Bunch coalescing system at low energy for high intensity machines

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Fermilab, 9/1/2010

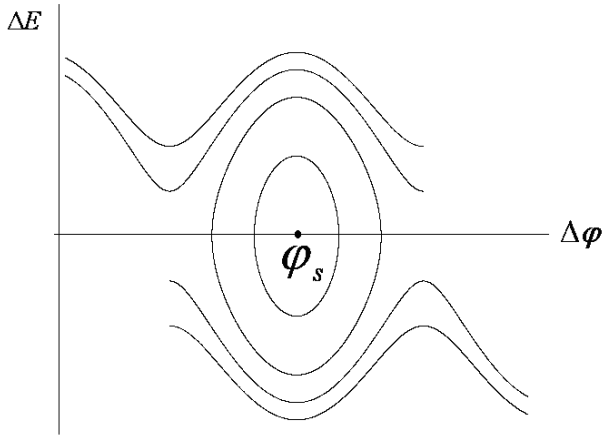
Intro

- Project X – high intensity proton accelerator complex

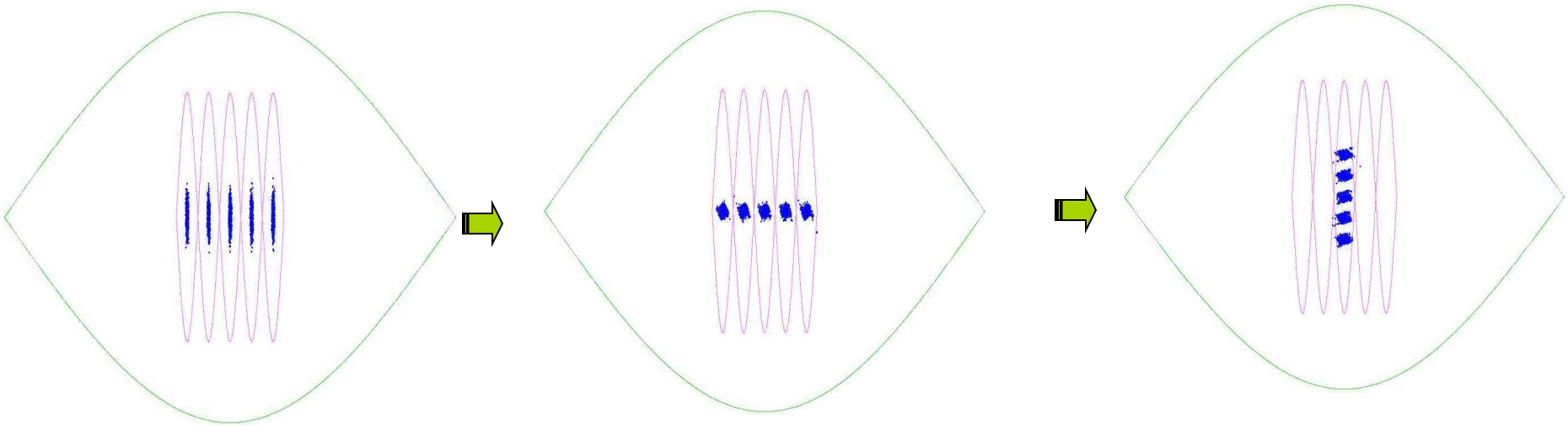
  Intensity of the beam I_x= 2.5*10^11 ppb

  (5 times higher than current intensity)
- High intensity beam at low energy research is required (ex: space charge effects)
- We need to create a system providing high intensity beam at low energy

Longitudinal dynamics and bunch coalescing



$$\Delta E^2 + \frac{2v^2 E_s eV}{\eta \omega_{rf} \tau c^2}(\cos\varphi + \varphi \sin\varphi_s) = const$$



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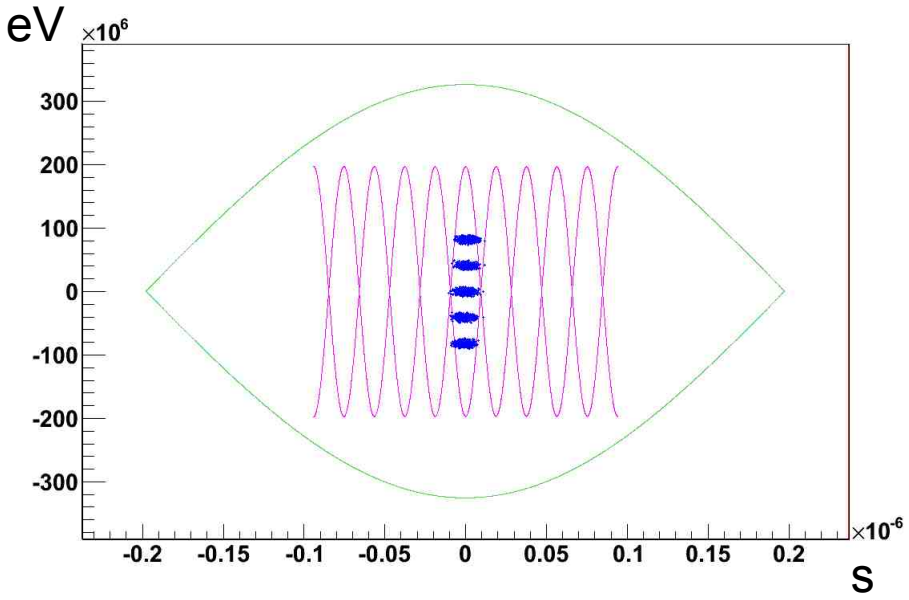
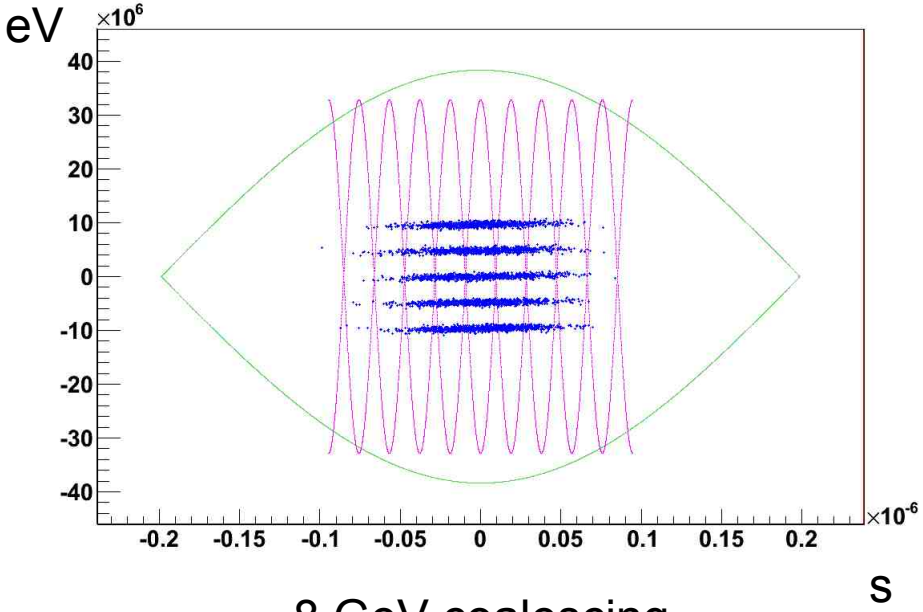
Bunch coalescing at low and at high energy

- Synchrotron oscillation frequency (65 kV, 2.5 MHz)

$$f_h \approx 5Hz \qquad f_l \approx 46Hz \qquad \frac{\Delta T_l}{\Delta T_h} = \frac{\Omega_{sl}}{\Omega_{sh}} \approx 9$$



150 GeV coalescing



8 GeV coalescing

The goal of my work

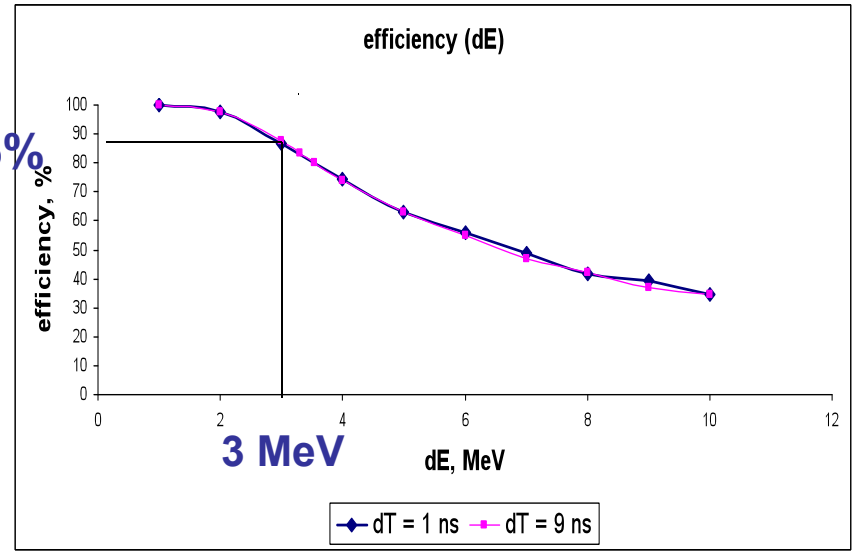
To perform simulations of coalescing process at low energy and optimize the parameters for 85% coalescing efficiency

To make bunch coalescing at low energy experimentally. Compare with simulations.

Simulations

Initial conditions: 0.1eVs

Rotation at 2.5MHz bucket

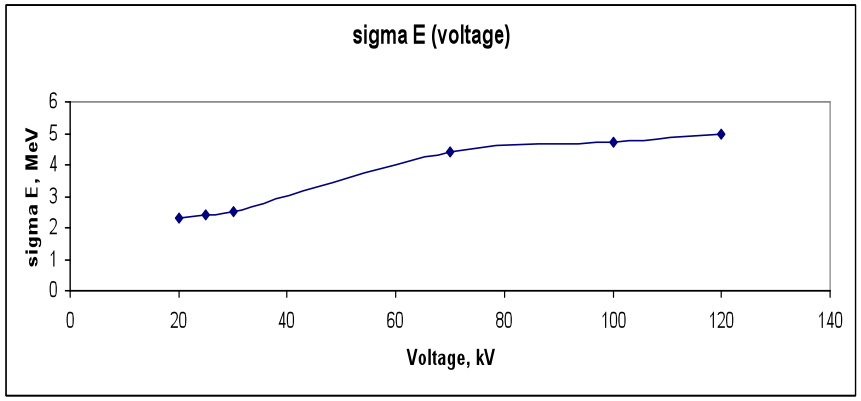


85%

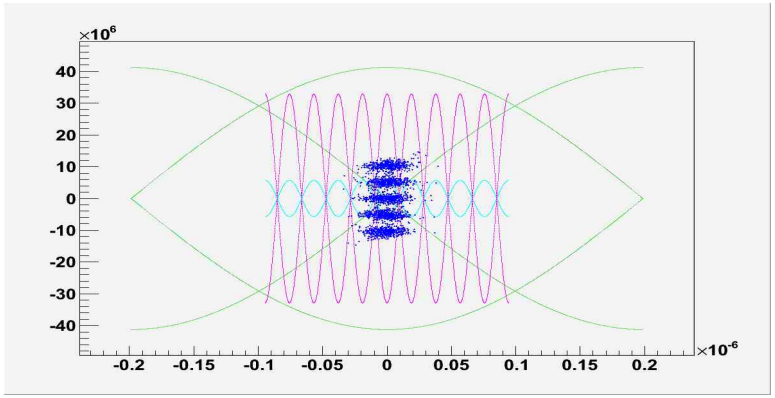
3 MeV

Required energy spread before rotation < dEmax= 3 MeV

Adiabatic dumping

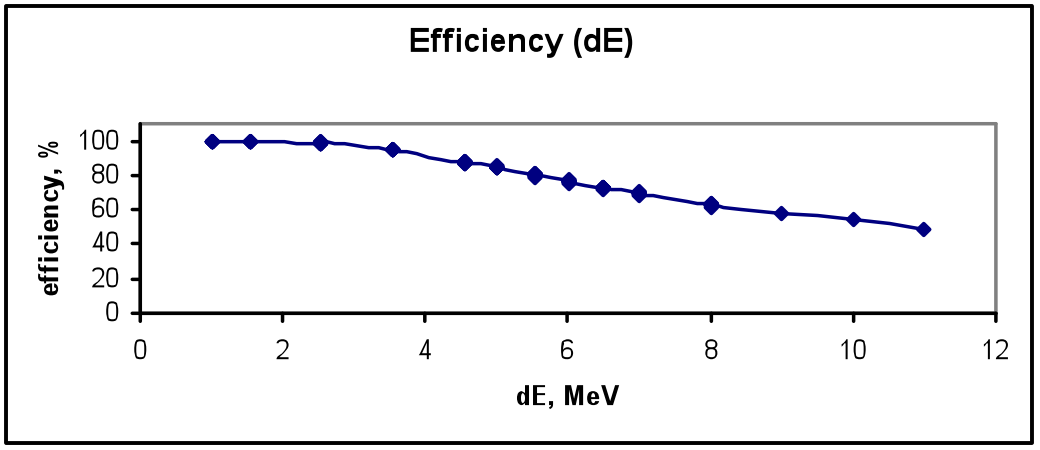


The minimum energy spread after adiabatic dumping is dEmin= 4.6 MeV



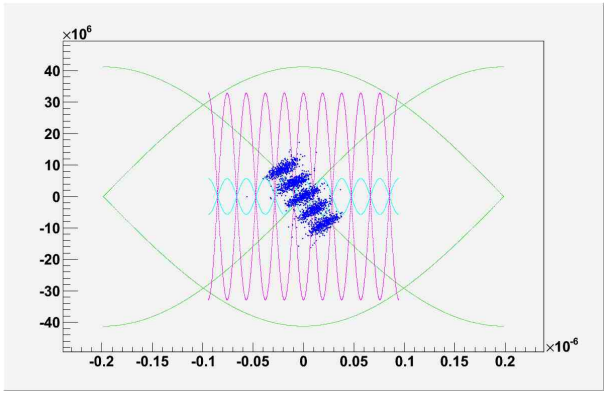
Simulations

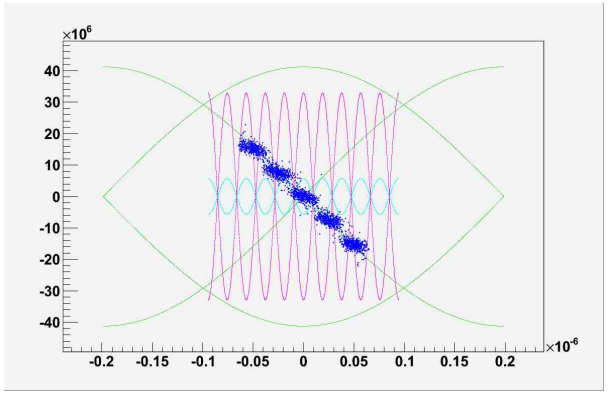
Bunch stretching

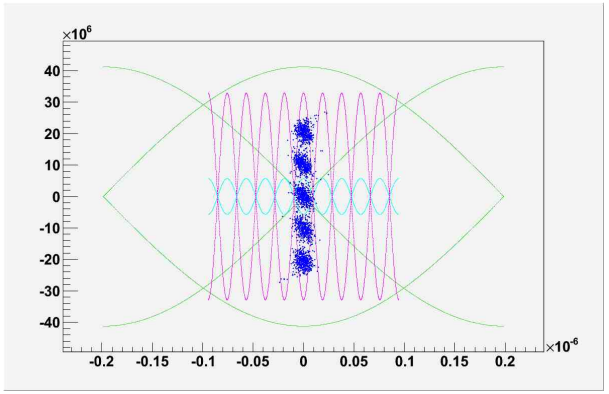


dE_{max}= 5 MeV

Efficiency = 85%





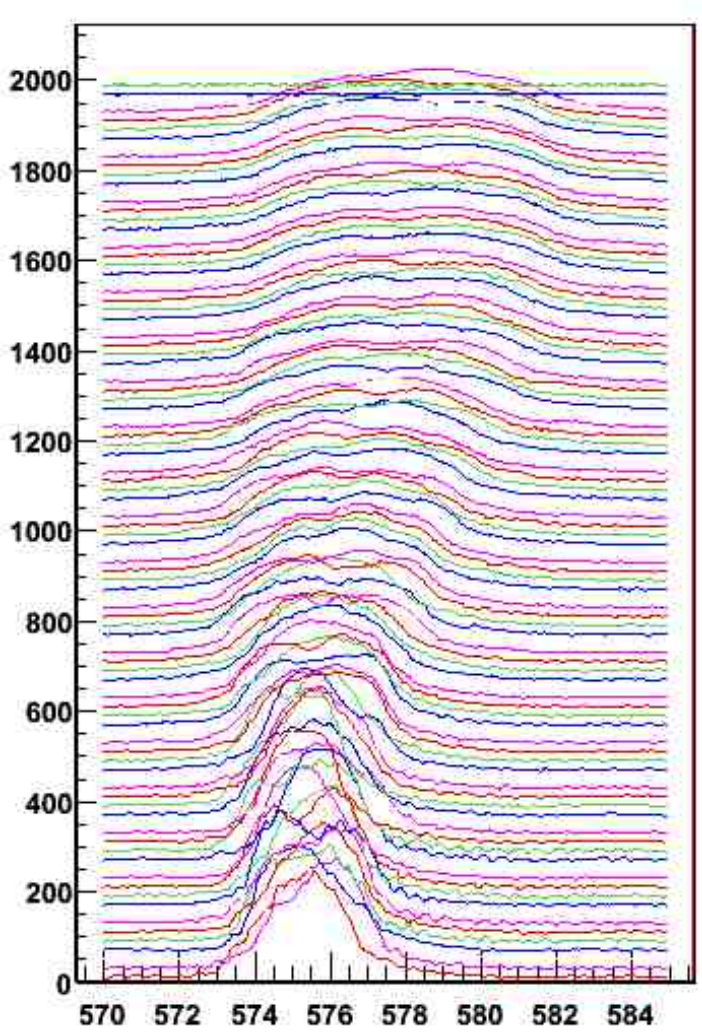


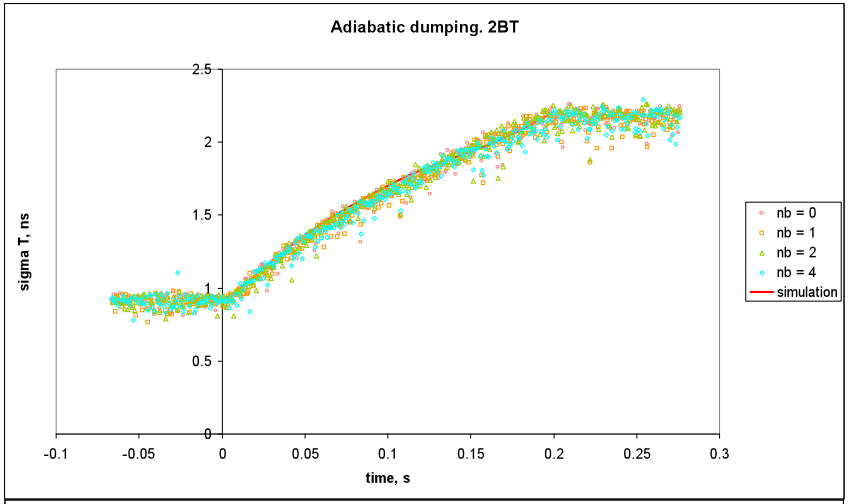
Coalescing parameters

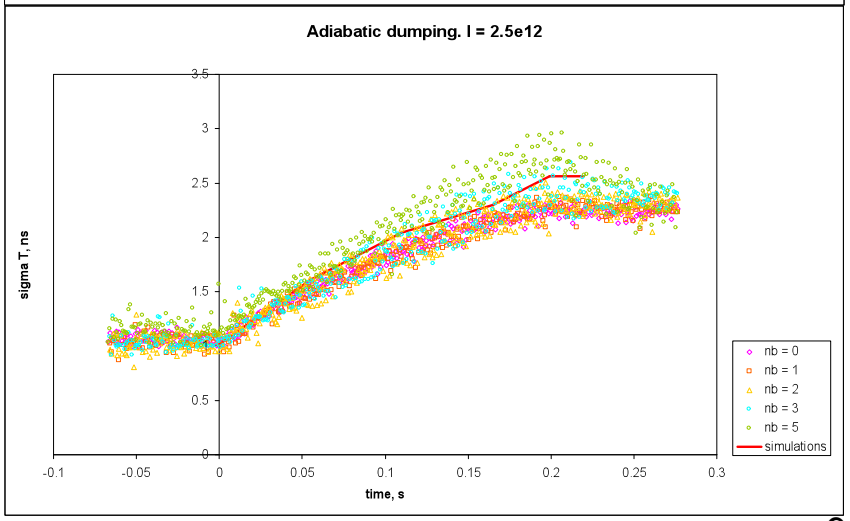
Process	Parameters
Adiabatic dumping	Adiabatic time = 0.02 s Vinitial = 1MV ,Vfinal = 30 kV
Bunch stretching	Stretching time = 2.5 ms±0.1ms
Rotation at 2.5 MHz	Voltage = 75 kV. Time before stretching 7.7±0.1ms, time after stretching 17.4±0.1ms ms

But now there is only 1.3 ms time resolution

Adiabatic dumping





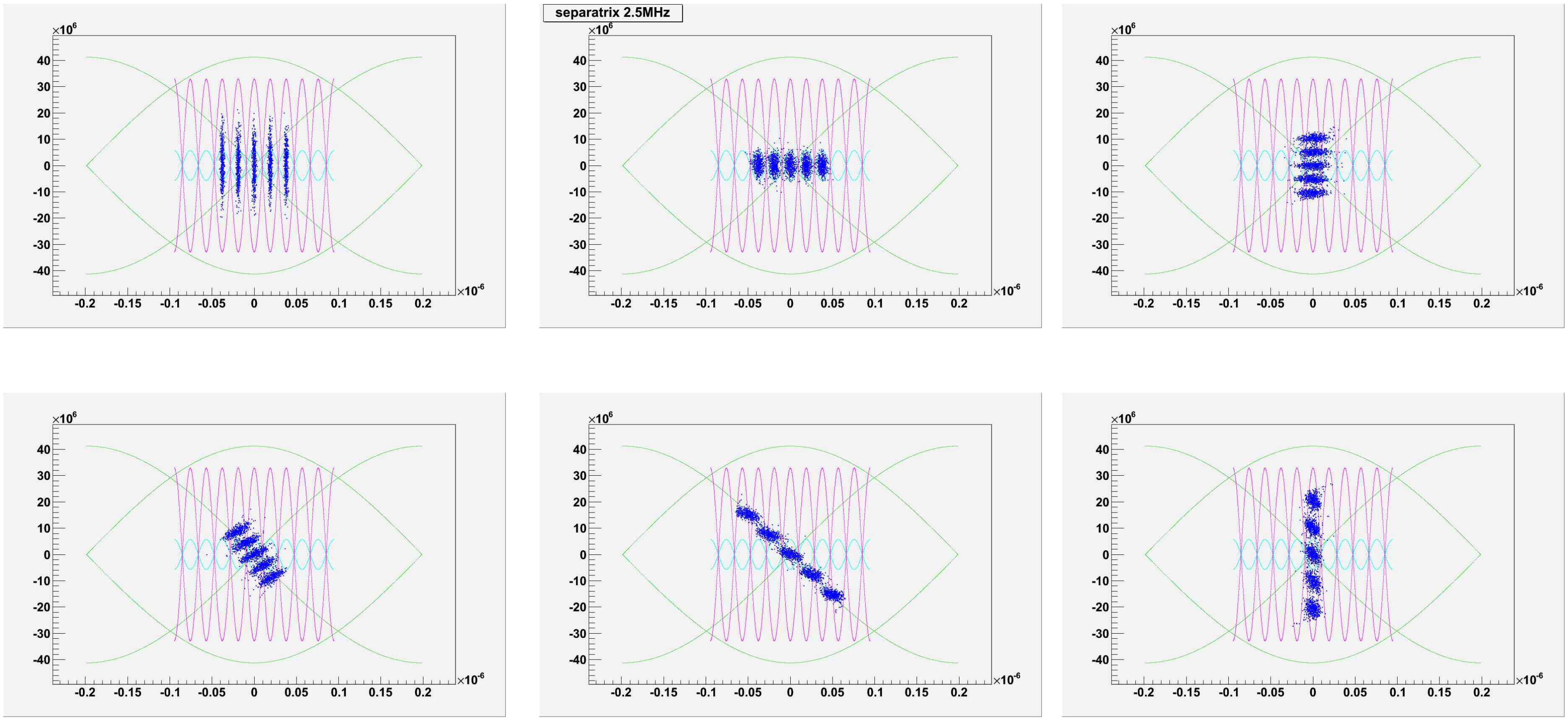


Conclusion

- Simulations of bunch coalescing at low energy were performed. The parameters for timing and voltage were optimized. It was shown that 85% coalescing efficiency could be achieved at low energy.
- Adiabatic dumping at low energy was performed experimentally. The results agree with simulations.

Additional slide:

Bunch coalescing process at low energy



Additional slide: Bunch stretching